SIMPOSIO DE BIOECONOMIA EN AMERICA TROPICAL
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Antoine Milhau (milhau.antoine@gmail.com)
Abigail Fallot (fallot@cirad.fr; afallot@catie.ac.cr)

Production and availability of agricultural residues for energy in LAC and EU

learning from the Indian experience.

Agricultural residues

	Primary	Secondary
Origin	In the field during agricultural practices or during harvest	In a related industry during transformation of the main product
Examples	Straw, stalks, leaves	Bagasse, shells, fibers
Characteristics	Heterogeneity Spread over large areas	Homogeneity Concentrated in the industry
		

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Agricultural residues for energy production

- Abundance and renewability
- Cheaper biomass than dedicated plantations
- Complementarity rather than competition with food production
- Local resource, available in every agricultural area

- Low energy density
- Seasonal variations and instability
- Availability limited by competitive uses
  - Soil management (fertility, erosion)
  - Animal feed
  - Construction material
- Spread over large areas → high cost collection

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How much residues are produced?
At what conditions are they available for industrial energy production?

- **Focus on EU and LAC regions**
- **Results and discussion based on the Indian experience in the industrial energy use of agricultural residues**

Assessment methodology for…

Crop residue production

From FAO-Stat 2007-2011

Agricultural production

Residue-to-product ratios:
- Specific value for each residue
- Estimated from literature
- Ex: 1.3T straw produced / T wheat

x **rpr**

GTP Gross technical potential

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Crop residue availability

Recoverability factors after agricultural or other uses
- Global value for primary and secondary residues
- Estimated from literature
- Ex: 15% and 55% of primary and secondary respectively remain available after agricultural needs

GTP Gross technical potential

x RF_{agri}

NTP Net technical potential

Agricultural uses
- Soil
- Animal feed

x RF_{other}

PP Practical potential

Other uses
- Domestic fuel
- Construction

Crop residues selected for productions assessment in EU-28 and LAC

29 crop residues from 21 crops

PRIMARY RESIDUES	• Straw from cereals, soybean, mustard and rapeseed • Stalks from sunflower, maize and cotton • Residues from pineapple harvest • Coconut fronds • Groundnut haulms • Sugarcane tops and leaves • Coffee branches • Banana rachis
SECONDARY RESIDUES	• Sugarcane bagasse • Groundnut shells • Coconut shell, husks and pith • Rice husk • Corn cob • Oil palm empty bunches, fibers

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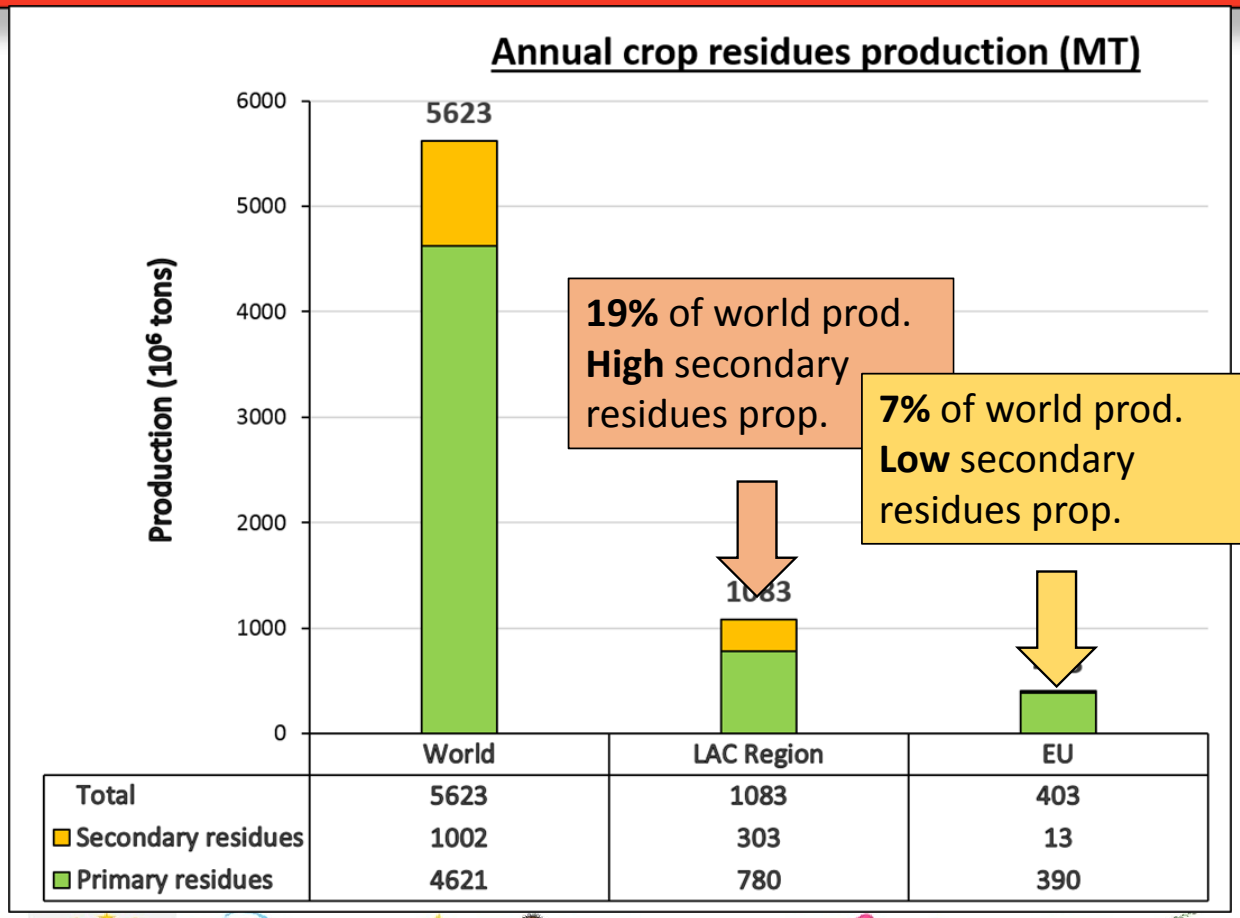
Crop residues generated by agricultural production in EU-28 and LAC



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Crop residues generated by agricultural production in EU-28 and LAC

In EU-28

- 7 % of world crop residues production
- Only 3% secondary residues
- Straws of wheat and barley + stalks of maize and rapeseed = 85% residue production
- France, Germany, UK, Poland and Spain = 5 main producers (60% of EU production)

In LAC

- 19 % of world crop residues production
- 72% are primary; 28% are secondary
- Sugarcane bagasse / tops and leaves + Soybean and maize stalks = 81% residue production
- Brazil = 60% of LAC crop residues production
- Brazil, Argentina, Mexico, Colombia

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Availability

	Primary residues	Secondary residues
Fraction dedicated to soil and animal feed	85%	45%
Fraction dedicated to other uses	20%	60%

Availability = small part of residues generated

(PP = 12-15% of GTP)

GTP 403 Mt → **NTP** 65 Mt → **PP** 49 Mt

6% secondary

GTP 1083 Mt → **NTP** 283 Mt → **PP** 160 Mt

41% secondary

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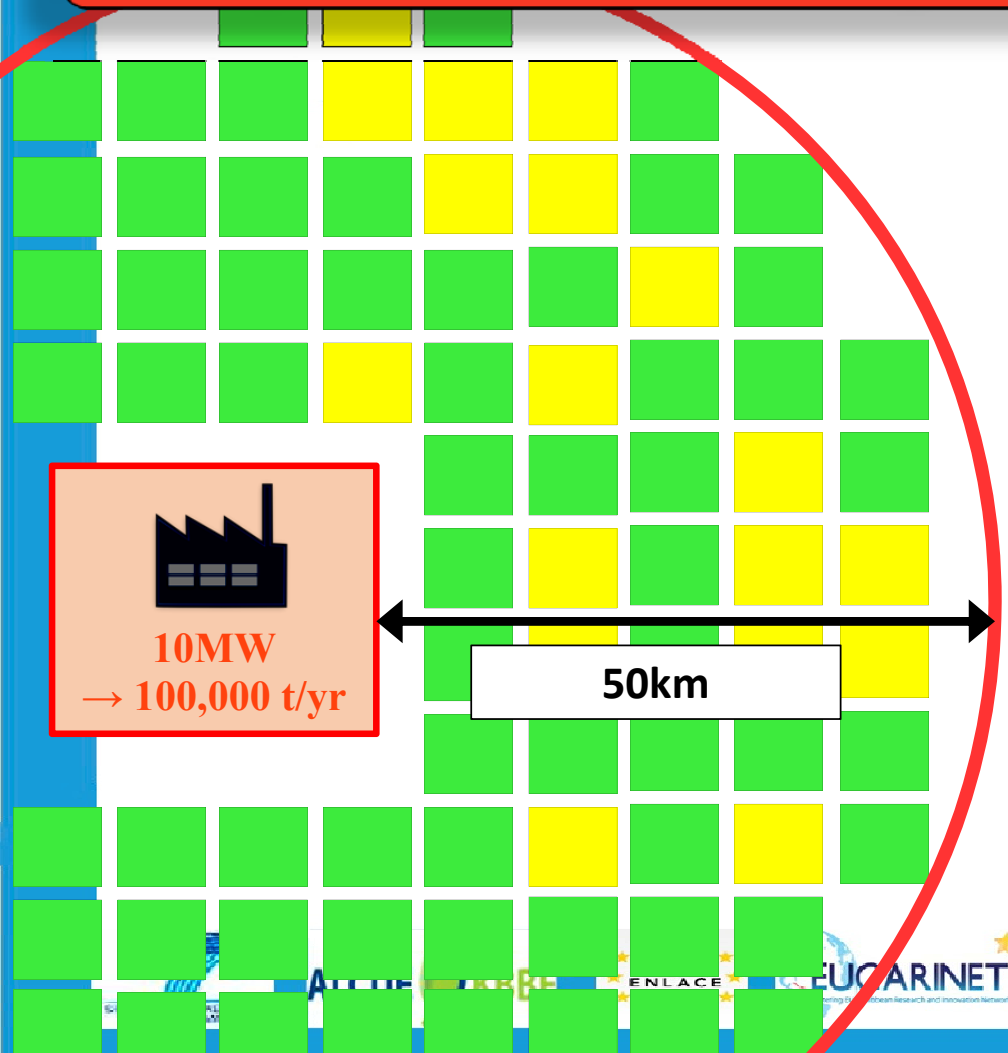
Primary residues availability limited by costs and transportation



EXAMPLE WITH RICE

Straw: 5 ton/ha generated (GTP)
0.7 ton/ha potentially available (PP)

In a region where rice use 30% of land

→ 476,000ha are needed to feed a 10MW plant

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Learning from the Indian experience

Energy Policy 58 (2013) 391–402

Contents lists available at SciVerse ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Assessing the potentials of agricultural residues for energy: What the CDM experience of India tells us about their availability

Antoine Milhau [a,b], Abigail Fallot [a,b,c,*]

- Assessment of crop residues production and their availability
- Compare with how they are use for energy production through the CDM experience
- → understand **conditions in which crop residues can be mobilized for energy production**

Learning from the Indian experience

The Indian Context

- **2010, India generated 0.6 billion tons crop residues = 10% world production**
- **2004-2010: 136 CDM using crop residues for energy generation → data**
  - Installed capacity of 1300MW (0.8% total installed cap.) (9.8MW/project on average)
  - Mainly consume secondary residues: rice husk and bagasse
  - Primary residues poorly exploited: 1-3% PP, mainly cotton stalks
  - Technology: Direct combustion, energy for captive use or sold to the grid
  - Average efficiency: 0.6 kWh/kg residues

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Observed Consequences:

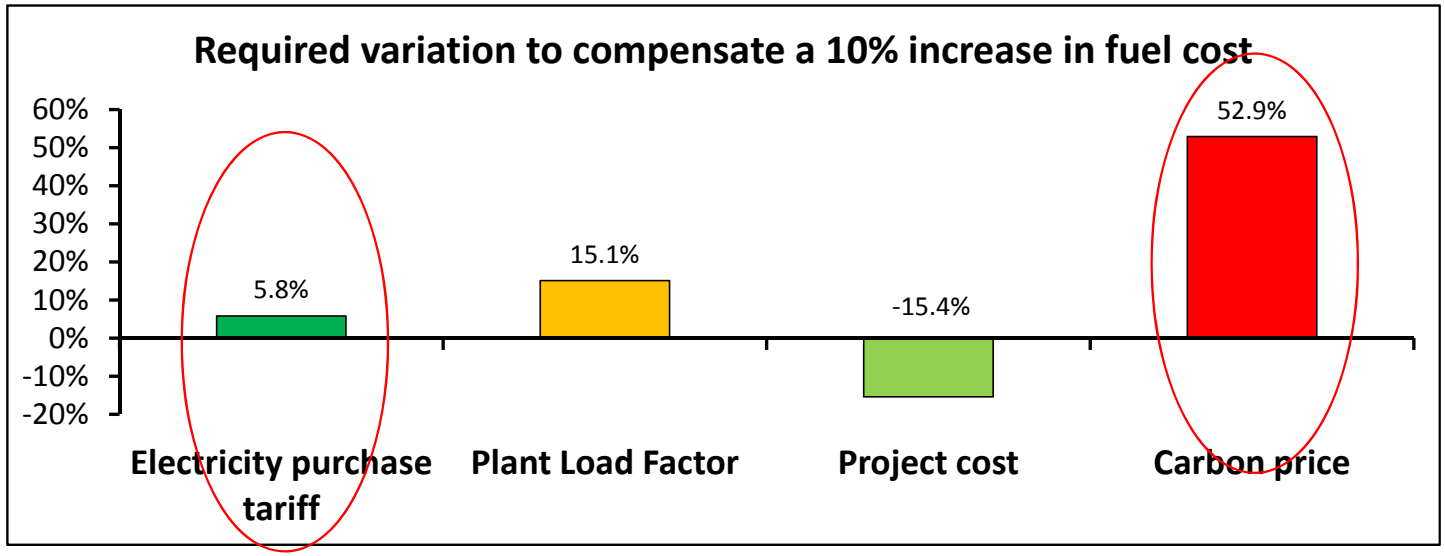
Exhaustion of a few residues Vs. Potentials of other remain largely untapped

Agricultural residues price increases by 30% between 2004 and 2010

Technology limited for full exploitation of the energy potential

Conditions for the exploitation of residues

- **Financial analysis**, based on IRR, gives information concerning important parameters to maintain viability of projects:
  - Electricity purchase tariff and crop residues cost: most determinant factors.
  - Carbon credits: impulse projects implementation but cannot compensate for fuel cost increase.



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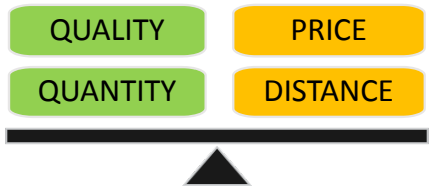
Conditions for mobilizing residues for energy production

AVAILABILITY

Crop residue generated ≠ available for energy production
Think first: SOIL, ANIMAL FEED AND OTHER USES previously
Global asses.: 15% residues generated are available for energy, must be adjust at local level

Projects feasibility



Secondary residues are more attractive : food industries can transform crop residues into energy for captive use → economic incentive.

More risky to implement profitable energy plant that have to collect and transport residues to make energy and sell it to the grid.

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Projects viability

CONSTANCY OF RESIDUE PRODUCTION (Depends on climate, markets, agricultural policies…)

PRICE OF THE BIOMASS (including transportation cost)

- New market for residues, without regulation → prices rise up
- Risk: residues can be sold for energy with negative impact on soil and agric. production

ELECTRICITY PURCHASE TARIFF

- Determinant factor for feasibility and viability of projects
- Needs for politics decision to state on the electricity produced from residues

CARBON PRICE : « good to take but not determinant incentive »,

- cannot absorb residue price increase

Perspectives for energy production from residues in LAC and EU

In LAC, situation similar to India

- Important quantity of residues generated (++ secondary residues) but projects didn't boomed in LAC as in India
- Obstacle: Electricity purchasing conditions limit adoption of projects (Mexico & Colombia, pioneers in small scale)
- Industrial opportunity for economic and environmental competitiveness (Bagasse valorization largely adopted…)
- Alternative: residues can be transform into biomaterial
- Challenge: improve technology efficiency and provide market for the energy
- Caution: projects should be go with measures to prevent take off residues from soils, animals or other uses

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In EU-28

- Scarcity of secondary residues limits projects feasibility
- Experiences of large-scale energy production from straw in Denmark, UK…
- Obstacle: availability and constancy of resource → residues mixed with other fuels such as wood or coal
- European countries can invest in residue projects in developing countries through CDM

Thank you for your attention

Antoine Milhau (milhau.antoine@gmail.com)
Abigail Fallot (fallot@cirad.fr)

Questions?
Discussion